PATENT SPECIFICATION

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Sterilization Method and Apparatus

We, THE BENDIX CORPORATION, a corporation of the State of Delaware, United States of America, of The Fisher Building, Detroit, Michigan, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a method and apparatus for inactivating and killing microorganisms or germs and more particularly to a method and apparatus for cleaning and sterilizing bacteria contaminated articles by the utilization of a germicidal solution and the cavitational action of sonic energy.

An object of the present invention is to provide a method and apparatus for microscopic cleaning and sterilizing by the action of a germicidal solution, which is subjected to cavitation.

Another object of the present invention is to provide a method and apparatus for microscopic cleaning and sterilizing of bacteria contaminated articles rapidly and economically.

Present methods of killing microorganisms sterilization of articles include: the use of a germicidal solution whereby the solution comes in contact with the cell of the microorganism and chemically kills the cell; the application of sonic energy through a fluid medium whereby the cell is destroyed by rupturing of the cell wall; and the use of a standard autoclave which destroys the microorganism by applying heat under pressure to the cell. The above methods have several drawbacks in the killing of microorganisms. These drawbacks include: the incomplete sterilization of the articles; the inadequate physical cleaning of the articles; degree of heat and pressure required, and the excessive time necessary for satisfactory cleaning and sterilization. A further object of the invention is to provide an economical method and apparatus which advantageously incorporates the features of a germicidal solution and sonic energy and utilizes the inter-reaction of each feature.

Microorganisms may be classed in two groups: those which form clumps or chains and those which do not group in this fashion. Microorganisms, and in particular bacteria are found in either of these two groups. A small percentage of the bacteria found are spore forming bacteria which form a resistant coating and thereby become more difficult to kill. Most present methods of killing bacteria and sterilization of articles are capable of killing the non-spore forming bacteria but have substantial difficulty in killing spore forming types. A still further object of the present invention is to provide a method and apparatus which kills the microorganism cells regardless of its grouping and type.

The invention may advantageously be utilized in the cleaning and sterilization of medical and dental clinical instruments. Instruments of this type have been found to be the most difficult to clean and sterilize because of the material deposited on the instruments and the type of bacteria which is present. The bacteria will in part be the spore forming type and may be encapsulated by various residues present in clinical environments such as dried blood, bone, enamel or dentine. Present methods of killing the bacteria and cleaning contaminated articles of this type are time consuming and are not economical. In present methods where sonic energy is utilised, the sonic energy is applied through a fluid medium producing compressional wave energy without cavitation. Sonic energy applied in this manner kills the bacteria cell by rupturing

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and has substantial difficulty in reaching all of the bacteria cells. Conversely, the invention utilizes sonic energy by applying the energy to a germicidal solution at frequencies and at a power to produce cavitation of the solution. The invention also combines the above utilization of sonic energy and a germicidal solution with an autoclave method and thereby advantageously uses the inter-reaction of a germicidal solution, sonics and autoclaving. The usefulness of the invention will therefore be apparent in the sterilization and cleaning of dental and medical instruments which must be microscopically clean and bacteria free.

The germicidal solution of the invention advantageously comprises a bactericidal agent, wetting agent-detergent, and water. The sonic energy, applied at a power and frequency sufficient to produce cavitation, and the wetting agent combine to effect a deagglomeration of the foreign encapsulating material and bacteria on the article to be sterilized and to effect a normal cleaning action on the article. The cavitation of the germicidal solution advantageously moves the bactericidal agent into contact with the bacteria cell allowing the cell to absorb the agent, it increases the effectiveness of the solution, and it mechanically moves the solution thereby allowing more of the fresh agent to be exposed to the bacteria cell. The sonic activation also removes coatings and waste products which accumulate on or in the vicinity of the microorganisms. The sonic activation of the germicidal solution increases the effectiveness of the sterilization by autoclaving and reduces the time, pressure, and temperature of the autoclaving procedures.

A still further object of the invention is to provide a method and apparatus for cleaning and sterilizing whereby sonic energy applied at a frequency and power sufficient to produce cavitation to a germicidal solution, increase the basericidal action of the solution, increases the cleaning and deagglomeration action of the solution, and improves the sterilization result of an autoclave process while reducing the time, pressures, and temperatures of the process required for normal autoclaving.

According therefore to the invention there is provided the method for microscopic cleaning and sterilisation of bacterially contaminated articles, which comprises the steps of inserting the articles in a pressure vessel, filling the vessel with a germicidal solution covering the articles, cavitating the solution by the application of sonic or ultrasonic energy and subjecting the articles to a sterilisation temperature and pressure, by increasing the temperature of and pressure on the germicidal solution.

The invention will now be described by way of example with reference to the accompanying drawing the single figure of which is a schematic diagram of one embodiment of the invention.

In one mode in which the invention is to be practiced, the contaminated articles are placed in a container and the container is inserted in a pressure vessel. A combined bacteria killing and cleaning solution is pumped into the vessel to a level which at a minimum completely covers the articles.

The water as used in the germicidal solution may advantageously be distilled water but the invention should not be construed to be limited thereto. The bactericidal agent may be any one of a large group of agents which will inactivate bacteria cells upon contact therewith. In the present invention several bastericidal agents which may be used advantageously are: Sodium Hypochlorite: Iodoform, a bactericidal Quaternary Ammonium Salt; Zephiran Chloride (the word Zephiran is a Registered Trade Mark); or Sodium Thiosulfate. Bactericidal solutions using the above agents may comprise for example: 1 part Sodium Hypochlorite and 1000 parts of water: 1 to 2 parts Iodoform and 100 Parts of water; 1 part Zephiran Chloride and 1000 parts of water; and 1 part Sodium Thiosulfate and 1000 parts of water. The wetting agent portion of the permicidal solution may be a detergent having surface-active and detergent properties. Any of a wide variety of detergents which have the above properties may be used, for example: a mixture of 80% Sodium Lauryl Sulfate and 20% Sodium Haxametophosphate; a mixture of 75% Sodium Orthosilicate and 25% Trisodium Phosphate: a mixture of 45% Sodium Metasilicate, 25% Sodium Bicarbonate, 25% Tetrasodium Phosphate, and 5% Sodium Lauryl Sulfate: and a mixture of 14 grams of Sodium Lauryl Sulfate and 14cc Ammonium Hydroxide.

Detergent solutions of the following proportions may be used: a solution of 3 to 7 ounces of a mixture of 80% Sodium Lauryl Sulfate and 20% Sodium Hexametaphosphate in one gallon of water: a solution of 2 to 8 ounces of a mixture of 75% Sodium Orthosilicate and 25% Trisodium Phosphate in one gallon of water: a solution of 2 to 9 ounces of a mixture of 45% Sodium Metasilicate, 25% Sodium Bicarbonate, 25% Tetrasodium Phosphate and 5% Sodium Lauryl Sulfate in one gallon of water: and a solution of 14 grams of Sodium Lauryl Sulfate, 14cc of Ammonium Hydroxide and one liter of water.

Germicidal Solutions of the following proportions may be advantageously employed in the invention: 0.1 to 1.0% of Sodium Hyphochlorite, a 1 to 5% of a mixture of 80% Sodium Lauryl Sulfate and

20% Sodium Hexametaphosphate and the remainder water; 0.1 to 1.0% of Zephiran Chloride, 1 to 5% of a mixture of 45% Sodium Metasilicate, 25% Sodium Bicarbonate, 25% Tetrasodium Phosphate and 5% Sodium Lauryl Sulfate and the remainder water; and 0.1 to 2.0% of Iodoform, 1.0 to 5% of a mixture of 75% Sodium Orthosilicate and 25% Trisodium Phosphate and the remainder water.

The germicidal solution is subjected to sonic energy at a frequency and amplitude sufficient to produce cavitation. The term "cavitation" defines several types of action including one in which tiny bubbles, present in the liquid and created by other actions, are made to collapse. Thus a cavitated germicidal solution experiences these violent pressure changes, at myriads of microscopically spaced volumes of microscopic dimensions. Such pressure changes break up clusters of bacteria, separate the clumps or chain grouping bacteria, disperse foreign encapsulating material, move the solution in the vessel and increase the effectiveness of the solution. A quick and positive bactericidal action of the germicidal solution results because of the ability of the sonic activation to break up the contamination and to throw it into suspension where it is readily attacked by the bactericidal agent, thus a blasting of the microorganisms into the solution results. In breaking down the clumps of bacteria the germicidal solution is in direct contact with each microbe. The mixing action of the sonic cavitation acts as a mass transfer agent and thus maintains the effectiveness of the bactericidal agent at a maximum at the locus of each bacterium. Therefore, the effect of cavitation on the germicidal solution is to increase the cleaning action of the detergent portion of the solution which in turn will increase the effectiveness of the bactericidal action of the solution, and make the bactericidal portion of the solution more available to the bacteria.

The above method of cleaning and sterilizing articles by cavitating a germicidal solution is satisfactory for many applications. The above method, for example in dental and medical uses, has removed the pathogenic microorganisms that might have been present before cleaning and sterilizing and thus has eliminated the possibility of mouth to mouth or patient to patient transfer of bacteria due to contaminated instruments. The economics surrounding the cleaning and sterilization will determine the method to be used, the present invention comprises the above method of utilizing a germicidal solution, cavitation by sonic energy and autoclaving.

The term autoclave has taken on several common meanings, for example, apparatus for sterilizing by superheated steam under pressure or a high pressure reaction vessel with internal heatings. As used herein, "autoclaving" will mean sterilization and cleaning by increasing the temperatures of and the pressure on a liquid. Effective sterilization may be accomplished by increasing the temperature of the germicidal solution to 280°F and by maintaining the pressure within the vessel at an upper limit of two atmospheres. A wide range of temperatures and pressures may be used in the invention, advantageous results may be obtained with a temperature range of 220° to 300°F and a pressure of substantially two atmospheres. Temperatures and pressure above these values do not ecomonically increase the results but within the invention higher temperatures and pressures may be used. The combined germicidal solution, application of sonic energy to said solution to produce cavitation thereof and autoclaving produce an economically feasible and time saving method of cleaning and sterilization. It has been found that the reduced time and temperature of autoclaving is a result of the increased effectiveness of the cleaning and bactericidal action. The germicidal solution is drained from the pressure vessel and the treated articles are spray rinsed with distilled water for final washing.

Another embodiment of the present invention comprises the steps of cavitating solution from the pressure vessel. Refilling the pressure vessel with the germicidal solution and autoclaving. Draining the solution and spray rinsing with water for final washing.

A further embodiment of the present invention comprises the steps of cavitating the germicidal solution and draining the solution from the pressure vessel. Refilling the pressure vessel with water and autoclaving. Draining the water and spray rinsing with distilled water for final washing.

The above processes suggest that increased cavitational action is desirable. This is true but the violence of the action reaches an economical limit whereby increased cavitational action does not produce proportionate results. Subjected to an alternating force, such as is presented by sonic energy, the liquid is subjected to recurring reductions and increases in pressures during which bubbles are enlarged and then collapsed. The forces of cavitation depend upon the change in bubble dimensions. The degree of this dimensional change increases with sonic energy intensity if frequency is unchanged and it decreases with frequency if sonic energy intensity is unchanged. Further, if frequency and sonic energy intensity are unchanged, the degree of cavitation violence increases with surface tension

of the cavitated liquid and decreases with vapor pressure.

Those skilled in the art use the term "sonics," or "ultrasonics," to include frequencies within the range of audible frequencies as well as those beyond that range. The term is used in that sense herein and is not limited to inaudible frequencies.

In practice, the degree of cavitation is limited by dispersion of the sonic energy waves by the bubbles created in the cavitation process. After the sonic energy is increased to the threshold level of cavitation, further increase causes relatively low incremental increase in cavitation violence. The increased energy is dissipated primarily as heat whereby the temperature of the cavitated liquid is raised.

The energy threshold for cavitation in a given liquid, while relatively constant at low frequencies, increases rapidly at higher frequencies. The result is that the lower limit for practicing the process is that the sonic energy input must exceed the cavitation threshold of the cavitated liquid for a given frequency. It has been found that the upper limit of sonic action is at that frequency and power at which the cavitation causes significant cellular damage or cellular rupture. Significant cellular damage or rupture will positively occur at such high levels of the combination of frequency and power at which no cavitation is present. No lower frequency limit is imposed but the frequency is advantageously kept below 50 kilocycles per second, below which threshold power levels are sufficiently low to preclude significant cellular damage or rupture of the bacteria either due to the cavitation or the compressional waves when there is no cavitation. By maintaining the frequency below 50 kilocycles per second the noise of an operating unit is kept to a minimum. At such operational frequencies and power as herein described the apparatus is of minimum size and relatively inexpensive.

With water as a constituent of the germicidal solution and at atmospheric pressure and the frequency less than 50 kilocycles per second, the power input must be in excess of the cavitational threshold power. For water this is one third watt per cubic centimeter of water to be cavitated.

Such variables as the pressure at which the invention is practiced and the surface tension and vapor pressure of the cavitated liquid only change the threshold level of sonic energy required for cavitation, if the sonic frequency is held below 50 kilocycles per second, they do not substantially effect the process but are only important to the economics of sonic energy production as long as cavitation is maintained.

The following examples are set forth as illustrations of the invention.

EXAMPLE I

The microscopic cleaning and the sterilization of clinical instruments which may be for example contaminated with dried blood, bone, enamel, and dentine which contamination includes spore forming and non-spore forming bacteria is accomplished by inserting the contaminated instrument in a pressure vessel and filling the vessel to a level covering the instruments with a germicidal solution consisting substantially of 0.1 to 1.0% of Sodium Hypochlorite, 1.0 to 5% of a mixture of 80% Sodium Lauryl Sulfate and 20% Sodium Hexametaphosphate and the remainder water. The temperature of the solution is increased to not more than 300°F and the pressure in the vessel maintained below two atmospheres, the solution being cavitated while maintaining the pressure and temperature for five minutes by subjection to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of the solution. The solution is drained from said vessel. The instruments are spray washed with water.

EXAMPLE II

The microscopic cleaning and the sterilization of clinical instruments which may be for example contaminated with dried blood, bone, enamel, and dentine which contamination includes spore forming and non-spore forming bacteria is accomplished by inserting the contaminated instruments in a pressure vessel and filling the vessel to a level covering the intruments with a germicidal solution consisting of 0.1 to 1.0% of Iodoform, 1.0 to 5% of a mixture of 75% Sodium Orthosilicate and 25% Trisodium Phosphate and the remainder water, and cavitation of the germicidal solution for three minutes as described in Example IV. The solution is drained from the vessel and the instruments washed with water. The vessel is refilled to a level covering the instruments with a germicidal solution of the above proportions, the temperature of the solution is increased to not more than 300°F and the pressure in the vessel is maintained below two atmospheres for five minutes. The solution is drained from the vessel and the instruments are spray washed with water.

EXAMPLE III

The microscopic cleaning and the sterilization of clinical instruments which may be for example contaminated with dried blood enamel, and dentine which contamination includes the Bacillus substilis (spore forming) bacteria and the Escherichia coli (non-spore forming) bacteria is accomplished by inserting the contaminated instruments in a pressure vessel and filling the vessel to a

level covering the instruments with a germicidal solution consisting of 0.1 to 1.0% of Sodium Hypochlorite, 1.0 to 5% of a mixture of 80% Sodium Lauryl Sulfate and 20% Sodium Hexametaphosphate and the remainder water and cavitating the germicidal solution for four minutes as described in Example IV. The solution is drained from the vessel and the instruments are washed with water. The vessel is refilled to a level covering the instruments with water and the temperature of the water is increased above 212°F and not more than 300°F, the pressure in the vessel being maintained below two atmospheres for five minutes. The water is drained from the vessel.

Referring now to the accompanying drawing, there is shown a cleaning and sterilization system having a pressure vessel 10 mounted on vessel mounting stand 11. Vessel 10 may advantageously comprise a substantially cylindrical section 12 having at one end thereof a permanent end closure 14 on the form of a hemispherical wall and the second end 15 disposed to receive door 16. Vessel 10 is mounted on stand 11 at three positions 18 and rigidly held thereto by any well known means (not shown). The portion of cylindrical section 12 which is joined to stand 11 will hereinafter be referred to as the bottom portion 19 of cylindrical section 12. Bottom portion 19 has an opening 20 disposed to receive transducer plate 21 which is held rigidly thereto by any well known means (not shown). Adequate sealing means 22 and 24 are provided for door 16 and transducer plate 21, respectively, to provide a fluid tight pressure vessel 10, a vessel capable of withstanding a build up of pressure.

The top of vessel 10 has an opening 25 therein for a safety relief valve 26 which will exhaust the fluids within vessel 10 upon a predetermined pressure having been reached. In the bottom portion 19 of the vessel 10 and disposed within said vessel is basket support 28 rigidly fixed to the interior wall of the vessel 10. Removable wire basket 29 is shown resting on support 28 and has a wire mesh portion 30 of such size to hold the smallest parts to be placed therein but of such size not to interfere with the activity of the sonically activated liquid disposed within the vessel 10. Heating coil 31 is disposed within the bottom portion 19 of vessel 10 for heating the fluid in said vessel. Heating coil 31 advantageously comprises a core metal heating element 32, an insulation 34 encompassing said core 32 and an outer metal element 35 encompassing said insulating material 34. Core metal heating element 32 and metal element 35 are connected to lead wires 36 and 38 which pass through the bottom portion 19 of vessel 10 to electrical plug 39 fitted into mounting stand 11. Plug 39 is readily accessible to a mating element connected to suitable eelectrical power source 40. Suspended from the top 41 of vessel 10 are a plurality of spray nozzles 42 which are connected to water supply line 44. Line 44 passes through the bottom portion 19 of vessel 10 to fitting 45 mounted in stand 11. Fitting 45 is readily accessible to a mating element connected to a suitable water supply source 46.

The numerals 48 and 49 designate magnetostrictive transducers fixed to transducer plate 21 which is adopted to transmit the sonic or ultrasonic energy to the germicidal solution in the vessel. Within the scope of the invention any number of transducers may be employed depending upon the vessel structure and the liquid activation required. Permanent magnets 50 and 51 are interposed between the legs of the transducers 48 and 49 applying unidirectional magnetism to the transducers. Alternating magnetizing forces are applied to the transducers 48 and 49 by means of windings 52 and 54 which are connected by wires 55 and 56 to electrical plug 58. Plug 58 is mounted in stand 11 and is readily accessible to a mating element connected to sonic supply source 59. Mounting stand 11 is advantageously provided with ventilating holes 60 for cooling transducers 48 and 49. Cooling air is supplied to the transducer area by means of tubing 61 which is in fluid communication with fitting 62 mounted in stand 11. Fitting 62 is readily accessible to a mating element connected to a suitable air supply 64.

Fluid is supplied to and drained from pressure vessel 10 through port 65 in the bottom portion 19 of the vessel 10. Port 65 through pipe 66 is in fluid communication with three way valve 68. Valve 68 is in fluid communication with supply fitting 69 mounted in stand 11 by means of pipe 70, pump 71, and pipe 72. Supply fitting 69 is readily accessible to a mating element connected to the supply tanks 74. Pump 71 is disposed to receive fluid from tanks 74 and to force the fluid through valve 68 into vessel 10. Valve 68 is in fluid communication with drain fitting 75 by means of drain pipe 76. Drain fitting 75 is readily accessible to a mating element connected to a drain container 78. Three way valve 68 has three positions (not shown), "fill", "drain", and "closed". In the "fill" position valve 68 will permit the flow of fluid from pump 71 into vessel 10 and close off the flow of fluid to drain fitting 75. In the "closed" position, valve 68 will shut off the flow of all fluid through valve 68. In the "drain" position valve 68 will permit the flow of fluid from vessel 10 to drain fitting 75 and close off the flow of

fluid from pump 71.

The operation of the cleaning and sterilization system will hereinafter be described, the process described in Example IV will be utilized in the description of operation and should not be construed to be limiting the invention to that process. The electrical plugs 39 and 58 and the fittings 45, 62, 69, and 75 are connected to suitable outlets heretofore described. The contaminated articles are inserted in wire basket 29 and door 16 is closed.

Three way valve 68 is moved to the "fill" position whereby the germicidal solution will flow from supply tanks 74 through pump 71, valve 68, port 65, and into vessel 10. Pump 71 forces the germicidal solution into the vessel until the desired level is reached when valve 68 is moved to the "close" position and all flow of fluid through port 65 is shut off. Electrical power form source 40 is turned on whereby the temperature of heating element 31 increases and an increase in the temperature of the germicidal solution will occur. The temperature of the solution is maintained at a predetermined level by control means (not shown) at the electrical source. The increase in temperature of the germicidal solution in the vessel will result in a corresponding increase in the pressure within vessel 10, which pressure is never permitted to exceed a predetermined level by means of safety relief valve 26.

While maintaining the temperature and pressure within the vessel 10 at a predetermined level sonic supply source 59 is turned to operate. Air supply 64 is turned on for cooling the transducers 48 and 49 during operation. Transducers 48 and 49 will transmit energy through transducer plate 21 and cavitate the germicidal solution in vessel 10. The sonic power applied, the pressure, temperature, and time limits have heretofore been described.

Upon completion of the cleaning and sterilization cycle, electrical source 40, sonic supply source 59 and air supply 64 are turned off and three way valve 68 is turned to the "drain" position. The solution and the removed contaminants will flow through port 65, drain fitting 75, and into drain container 78.

Valve 68 is turned to the "closed" position and water supply 46 is turned to operate. Water will flow from supply 46 through fitting 45 and supply line 44 to spray nozzles 42. The spray from nozzles 42 is directed across the articles disposed in basket 29. Water supply 46 is turned off and three way valve 68 is turned to the "drain" position. The cleaned and sterilized instruments are removed from basket 29.

WHAT WE CLAIM IS:—

1. The method for microscopic cleaning and sterilisation of bacterially contaminated articles, which comprises the steps of inserting the articles in a pressure vessel, filling the vessel with a germicidal solution covering the articles, cavitating the solution by the application of sonic or ultrasonic energy and subjecting the articles to a sterilisation temperature and pressure by increasing the temperature of and the pressure on the germicidal solution.

2. The method as claimed in claim 1, in which the articles are inserted in the pressure vessel, the vessel is filled with the germicidal solution covering the articles, and the solution is cavitated by the application of sonic or ultrasonic energy, which comprises the steps of draining the solution from the vessel, filling the vessel with a germicidal solution, subjecting the articles to a sterilisation temperature and pressure, by increasing the temperature of and the pressure on the germicidal solution, draining the latter solution from the pressure vessel and rinsing the articles with water.

3. The method as claimed in claim 1, in which the articles are inserted in the pressure vessel, the vessel is filled with a germicidal solution covering the articles, and the solution is cavitated by the application of sonic or ultrasonic energy, which comprises the steps of draining the solution from the vessel, filling the vessel with water, subjecting the articles to a sterilisation temperature and pressure by increasing the temperature of and the pressure on the awter and rinsing the articles with water.

4. The method as claimed in any of the preceding claims, in which the sonic or ultrasonic energy has a frequency less than 50 kilocycles per second.

5. The method as claimed in any of claims 1 to 3, in which the germicidal solution (or solutions) includes or include a bactericidal agent and a wetting agent.

6. The method as claimed in claim 5, in which the wetting agent is a detergent.

7. The method as claimed in claim 5, in which the bactericidal agent is either sodium hypochlorite, iodoform, a bactericidal quaternary ammonium salt, zephiran chloride or sodium thiosulfate.

8. The method as claimed in claim 7, in which the germicidal solution is either 1 part sodium hypochlorite and 1000 parts of water, 1 to 2 parts iodoform and 100 parts of water, 1 part zephiran chloride and 1000 parts of water or 1 part sodium thiosulfate and 1000 parts of water.

9. The method as claimed in claim 6, in which the detergent agent is either a mixture of 80% sodium lauryl sulfate and 20% sodium hexametaphosphate, a mixture of 75% sodium orthosilicate and 25% trisodium phosphate, a mixture of 45% sodium metasilicate, 25% sodium bicarbo-

nate, 25% tetrasodium phosphate and 5% sodium lauryl sulfate or a mixture of 14 grams of sodium lauryl sulfate and 14cc ammonium hydroxide.

10. The method as claimed in claim 9, in which the detergent solution is either 3 to 7 ounces of a mixture of 80% sodium lauryl sulfate and 20% sodium hexametaphosphate in 1 gallon of water, 2 to 8 ounces of a mixture of 75% sodium orthosilicate and 25% trisodium phosphate in 1 gallon of water, 2 to 9 ounces of a mixture of 45% sodium metasilicate, 25% sodium bicarbonate, 25% tetrasodium phosphate and 5% sodium lauryl sulfate in 1 gallon of water or 14 grams of sodium lauryl sulfate, 14cc of ammonium hydroxide and 1 liter of water.

11. The method as claimed in any of claims 1 to 3, in which the germicidal solution consists either of 0.1 to 1.0% of sodium hypochlorite, a 1 to 5% mixture of 80% sodium lauryl sulfate and 20% sodium hexametaphosphate and the remainder water; 0.1 to 1.0% of zephiran chloride, a 1 to 5% mixture of 45% sodium metasilicate, 25% sodium bicarbonate, 25% tetrasodium phosphate and 5% sodium lauryl sulfate and the remainder water; or 0.1 to 2.0% of iodoform, a 1.0 to 5% mixture of 75% sodium orthosilicate and 25% trisodium phosphate and the remainder water.

12. The method for microscopic cleaning and sterilisation as claimed in claim 1 of clinical instruments contaminated with dried blood, bone, enamel or dentine which contamination includes spore forming and non-spore forming bacteria which comprises the steps of inserting the contaminated instruments in the pressure vessel, filling the vessel to a level covering the instruments with a germicidal solution consisting of 0.1 to 1.0% of sodium hypochlorite, 1.0 to 5% of a mixture of 80% sodium lauryl sulfate and 20% sodium hexametaphosphate and the remainder water, increasing the temperature of the germicidal solution to not more than 300°F and maintaining the pressure in the vessel below 2 atmospheres, cavitating the germicidal solution, while maintaining the pressure and temperature, for five minutes by subjecting the latter to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of the solution, draining the solution from the vessel and spray washing the instruments with water.

13. The method for microscopic cleaning and sterilisation as claimed in claim 2 of clinical instruments contaminated with dried blood, bone, enamel or dentine which contamination includes spore forming and non-spore forming bacteria which comprises the steps of inserting the contaminated instruments in the pressure vessel, filling the vessel to a level covering the instruments with a germicidal solution consisting of 0.1 to 1.0% of iodoform, 1.0 to 5% of a mixture of 75% sodium orthosilicate and 25% trisodium phosphate and the remainder water, cavitating the germicidal solution for three minutes by subjecting the latter to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of the solution, draining the germicidal solution from the vessel, washing the instruments with water, refilling the vessel to a level covering the instruments with a germicidal solution of the above proportions, increasing the temperature of the solution to not more than 300°F and maintaining the pressure in the vessel below 2 atmospheres for five minutes, draining the latter solution from the vessel and spray washing the instruments with water.

14. The method for microscopic cleaning and sterilisation as claimed in claim 3 of clinical instruments contaminated with dried blood, bone, enamel or dentine which contamination includes the Bacillus Subtilis (spore forming) and the Escherichiacoli (non-spore forming) bacteria which comprises the steps of inserting the contaminated instruments in the pressure vessel, filling the vessel to a level covering the instruments with a germicidal solution consisting of 0.1 to 1% of sodium hypochlorite, 1.0 to 5% of a mixture of 80% sodium lauryl sulfate and 20% sodium hexametaphosphate and the remainder water, cavitating the germicidal solution for four minutes by subjecting the latter to sonic energy at 20 kilocycles per second at a level of 2.5 watts per cubic centimeter of the solution, draining the solution from the vessel, washing the instruments with water, refilling the vessel to a level covering the instruments with water, increasing the temperature of the water above 212°F and not more than 300°F and maintaining the pressure in the vessel below two atmospheres for five minutes, and draining the water from the vessel.

15. An apparatus for carrying out the method as claimed in any of the preceding claims, which comprises a pressure vessel equipped with means for supplying and withdrawing liquid to and from the vessel, with a plurality of sonic or ultrasonic transducers attached in wave transmitting relation to the pressure vessel and with an electric heater device disposed in said vessel for increasing the temperature of liquid therein.

16. An apparatus as claimed in claim 15, in which the pressure vessel has an opening therein and a transducer plate disposed in the opening which is biased against the vessel so as to form a seal therewith, said plurality of ultrasonic transducers being in wave transmitting relation with the trans-

ducer plate.

17. An apparatus as claimed in claim 15 or 16, in which there is provided rinsing means for spraying a liquid over the articles after they are sterilised.

18. An apparatus as claimed in any of the claims 15 to 17, in which the pressure vessel is of cylindrical shape and has an hemispherical wall at one end and sealed door at the other end.

19. An apparatus as claimed in the preceding claims 15 to 18, in which there is provided a liquid port disposed in the pressure vessel and a valve in fluid communication with the liquid port for controlling the flow of fluid through the liquid port.

20. The method for microscopic cleaning and sterilisation of bacterially contaminated articles as claimed in claim 1 and substantially as herein described.

21. An apparatus for microscopic cleaning and sterilisation of bacterially contaminated articles constructed and adapted to operate substantially as herein described with reference to and as illustrated in the accompanying drawing.

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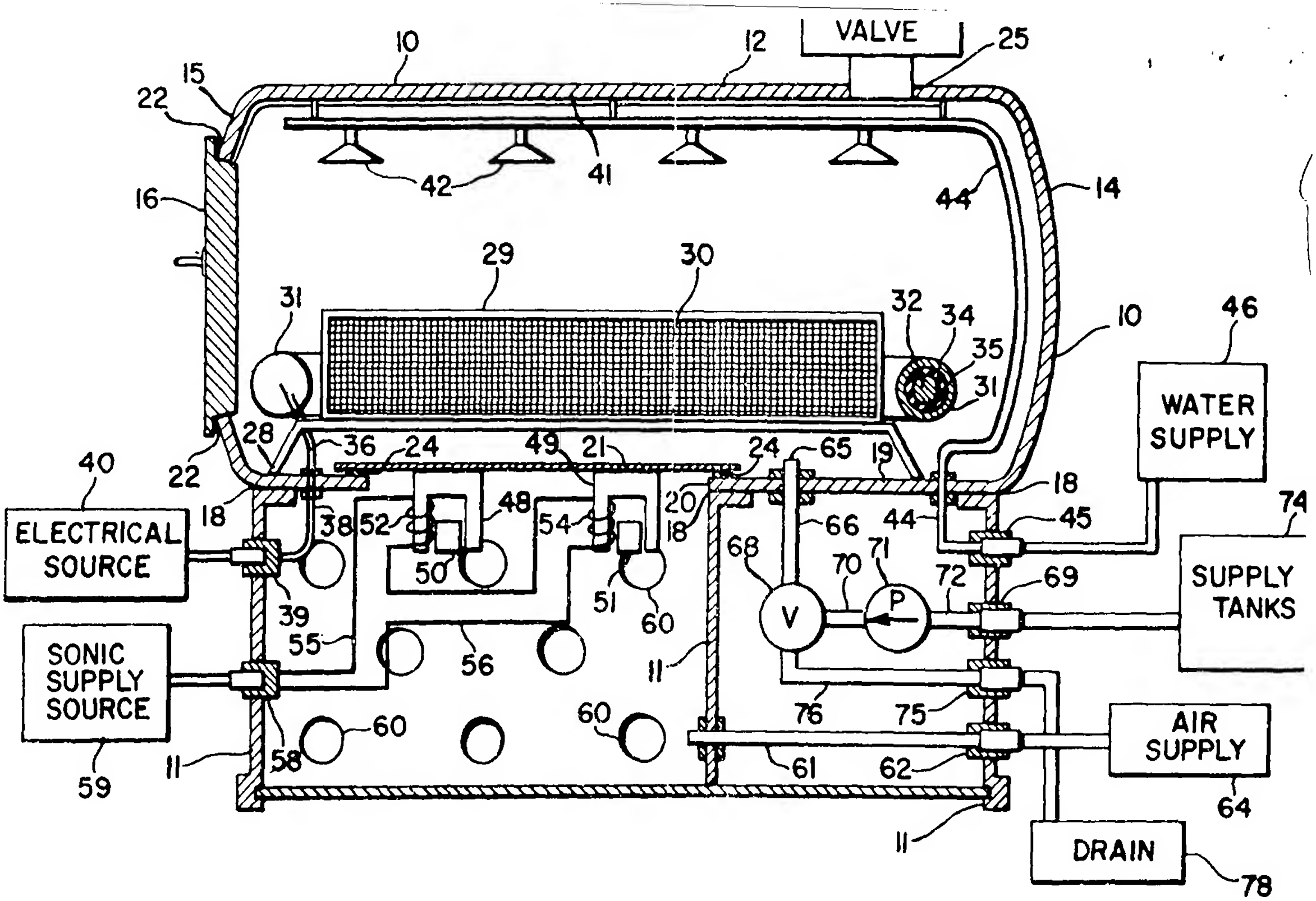
VALVE
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